

# REPORT DOCUMENTATION PAGE

Form Approved  
OMB No. 0704-0188

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<b>1. AGENCY USE ONLY (Leave blank)</b>		<b>2. REPORT DATE</b>	<b>3. REPORT TYPE AND DATES COVERED</b> FINAL/15 OCT 93 TO 14 OCT 94	
<b>4. TITLE AND SUBTITLE</b> SPECTRUM ALLOCATION STRATEGIES FOR COMMUNICATION NETWORKS			<b>5. FUNDING NUMBERS</b>	
<b>6. AUTHOR(S)</b>  ROBERT J. MCELIECE			2304/DS F49620-94-1-0005	
<b>7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)</b> CALIFORNIA INSTITUTE OF TECHNOLOGY DEPARTMENT OF ELECTRICAL TECHNOLOGY PASADENA, CA 91125			<b>8. PERFORMING ORGANIZATION REPORT NUMBER</b>  AFOSR-TR-95-0388	
<b>9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)</b> AFOSR/NM 110 DUNCAN AVE, SUTE B115 BOLLING AFB DC 20332-0001			<b>10. SPONSORING / MONITORING AGENCY REPORT NUMBER</b>  F49620-95-1-0005	
<b>11. SUPPLEMENTARY NOTES</b>				
<b>12a. DISTRIBUTION / AVAILABILITY STATEMENT</b>  APPROVED FOR PUBLIC RELEASE: DISTRIBUTION IS UNLIMITED			<b>12b. DISTRIBUTION CODE</b>	
<b>13. ABSTRACT (Maximum 200 words)</b> Models of multi-user communications systems have been developed and studied. The limits for such systems have been computed by linear programming.				
<div style="display: flex; justify-content: space-around; align-items: center;"> <div style="border: 2px solid black; padding: 10px; text-align: center;"> <p style="margin: 0;"><b>DTIC</b></p> <p style="margin: 0; font-size: 2em;"><b>S</b></p> <p style="margin: 0;"><b>ELECTE</b></p> <p style="margin: 0;">JUN 16 1995</p> <p style="margin: 0; font-size: 2em;"><b>D</b></p> <p style="margin: 0; font-size: 2em;"><b>F</b></p> </div> <div style="font-size: 3em; font-weight: bold;">19950614 049</div> </div> <p style="margin-top: 20px; text-align: center; font-weight: bold;">DTIC QUALITY INSPECTED 3</p>				
<b>14. SUBJECT TERMS</b>			<b>15. NUMBER OF PAGES</b>	
			<b>16. PRICE CODE</b>	
<b>17. SECURITY CLASSIFICATION OF REPORT</b> UNCLASSIFIED	<b>18. SECURITY CLASSIFICATION OF THIS PAGE</b> UNCLASSIFIED	<b>19. SECURITY CLASSIFICATION OF ABSTRACT</b> UNCLASSIFIED	<b>20. LIMITATION OF ABSTRACT</b> SAR(SAME AS REPORT)	

Final Technical Report, October 1, 1993–September 30, 1994

SPECTRUM ALLOCATION STRATEGIES  
FOR COMMUNICATION NETWORKS  
(AFOSR Grant F49620-94-1-0005)

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The long-term goal of this project has been to obtain a basic mathematical understanding of the problems associated with communication in the presence of severe noise, e.g., fading, jamming or interference from other (friendly) signals. Our basic approach has always been to apply the techniques and insights of *information theory* to these problems. In the period covered by this report, we continued, and greatly extended, our study of models for *multi-user* communication systems, i.e., systems in which many simultaneous two-way conversations must share a common band of frequencies. We have shown (refs. [4],[5],[6],[7],[9]) that the ultimate limits for such systems (measured by the number of conversations per unit of available bandwidth) can, in some cases, be computed by a fairly simple linear program. Later, we extended this work (ref. [16]) to show that it applies to the more general class of *blocking service networks*, i.e, networks which provide many kinds of service to many customers simultaneously. Besides “cellular” communication networks, we have already shown that our new theory also applied to ordinary telephone networks, and to stochastic “bin packing” TDMA communication networks. Most recently, we studied the performance of a class of practical bandwidth allocation algorithms, the “distributed dynamic” algorithms, and showed (ref. [21]) that in many cases they are nearly optimal.

In the past year, we continued, to explore this extremely fertile research area. Our most important result was a proof that the distributed dynamic algorithms referred to above are asymptotically optimal in a very strong sense, viz., for any value of the (normalized) offered traffic, as the number of channels becomes large, the carried traffic for these algorithms equals or exceeds that of any other algorithm (ref. [25]). We also found a class of modified algorithms which are a bit more complex, but which achieve optimality “faster” than the timid algorithm (refs. [23] and [24].)

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1. •"Performance of Binary Block Codes at Low Signal-to-Noise Ratios" (with C.-C. Chao, Eugene Rodemich, and Laif Swanson), *IEEE Trans. Inform. Theory* vol. IT-38 (1992) pp. 1677-1687.
2. "Some Properties of Memoryless Multiterminal Interference Channels," (with M. Mandell), Proc. 1991 International Symposium on Information Theory, p. 212.
3. "Dynamic Channel Assignment in Cellular Radio" (with Kumar Sivarajan and John Ketchum), Proc. 1990 IEEE Vehicular Technology Conference, pp. 631-637.
4. "Performance Limits for FDMA Cellular Telephone Systems" (with Kumar Sivarajan), Proc. 1990 Allerton Conference on Communication, Control, and Computing, pp. 869-880.
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